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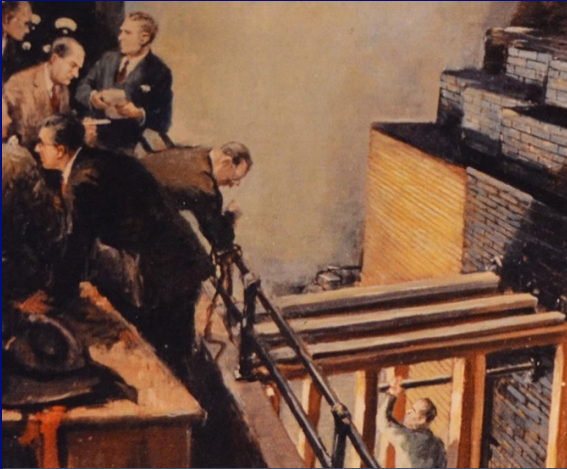
DOE National Laboratories: Vital to U.S. science and technology

Thom Mason
Laboratory Director

Saturday, August 7, 2021

LA-UR-21-27467

The national laboratory system



**Born from the
Manhattan Project**

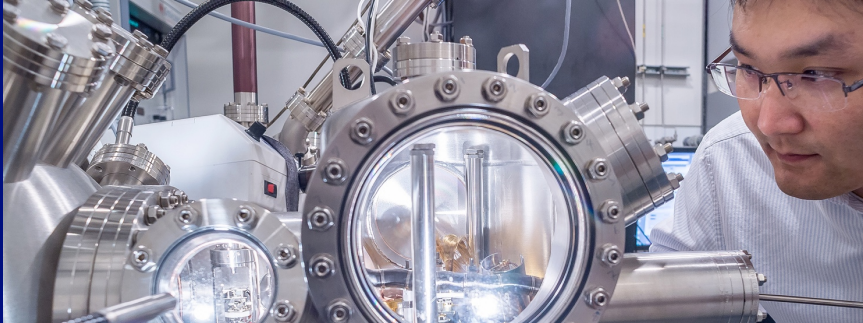


**Fundamental research,
national security, and
energy security**



**National
R&D force**

Critical missions that shape our nation, world



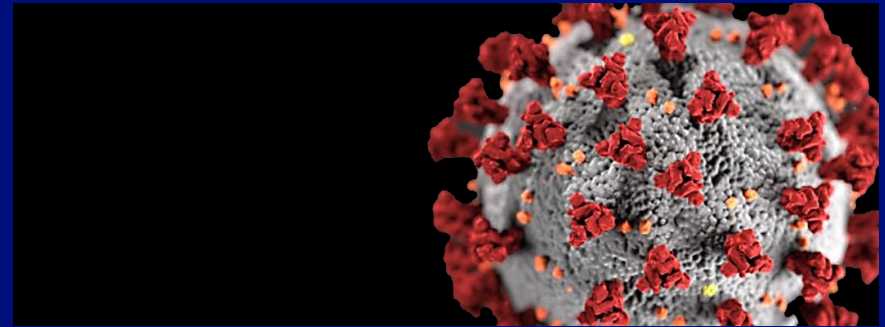
Enable breakthroughs that enable energy strategies work for the nation, world



Provide scientific and technical foundations for our national nuclear and global security

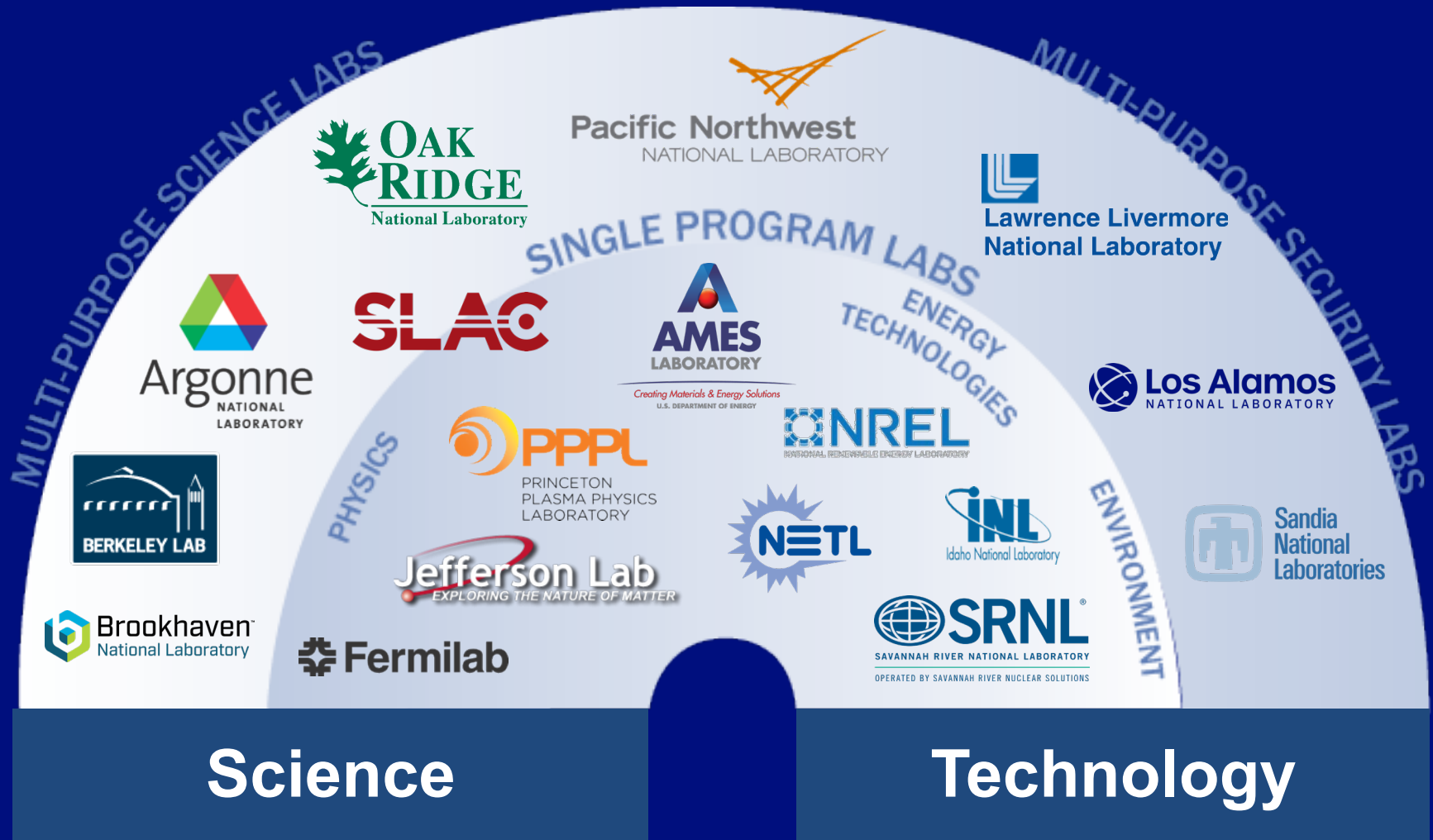


Create knowledge and understanding that will underpin our future society



Building tools to meet and manage future pandemics and biological threats

DOE executes missions through its diverse labs



Multipurpose science Labs:

Using unique combinations of facilities, programs to enable science



Hard X-rays;
Computing (open, big-
scale code diversity;
Energy storage and
transport



Free electron
laser science;
Ultrafast science
Accelerator
science



Neutron science;
Large-scale computing
Nuclear: Fission,
fusion, isotopes;
Applied Materials



Computing/network
ing: broad science
use Soft X-ray
science; Bio- and
earth- science;
Buildings efficiency



Chem. & molecular
sciences; Climate,
earth systems; Grid
(trans. & dist.); Ultra-
trace detection



Intermediate X-
rays; Quark-gluon
plasma; Accelerator
S&T

Single-purpose science labs:

Discovery of matter and force in the universe and gathering knowledge



- Elementary particle physics
- Accelerator science & tech.
- Particle astrophysics
- Fermilab accelerator complex



- Nuclear physics
- Accelerator science & tech.
- Applied nuclear science
- CEBAF facility



- Plasma physics
- Fusion energy science
- Plasma astrophysics
- NSTX-U facility

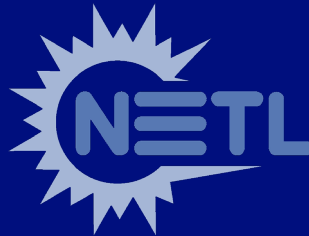


- Condensed matter physics
- Materials science
- Chemical & molecular science
- Applied materials & engineering

Energy labs are focal points for research in key sectors of energy economy



- Advanced Reactor Development
- LWR Sustainability & Industry support
- Reactor Fuel and Materials R&D
- Fuel cycle R&D, incl. disposition
- Nuclear and Critical Infrastructure Physical and Cyber Security



- Advanced Coal Combustion
- Carbon Capture and Storage
- Enhanced Oil Recovery (EOR) and Shale Gas Development
- Materials R&D for Coal, Oil & Gas Exploration



- Plasma physics
- Fusion energy science
- Plasma astrophysics
- NSTX-U facility



NNSA labs are dedicated to the science and technology of keeping the nation safe



- High Explosive and Actinide Sciences
- Materials
- Radiography



- Advanced Coal Combustion
- Carbon Capture and Storage
- Enhanced Oil Recovery (EOR) and Shale Gas Development
- Materials R&D for Coal, Oil & Gas Exploration



- Plasma physics
- Fusion energy science
- Plasma astrophysics
- NSTX-U facility

One lab serves as focal point for the DOE's environmental mission



- Environmental remediation and risk reduction
- Nuclear material processing and disposition
- Nuclear detection, characterization, and assessments
- Gas processing transfer and storage systems

Other labs lend expertise to this effort



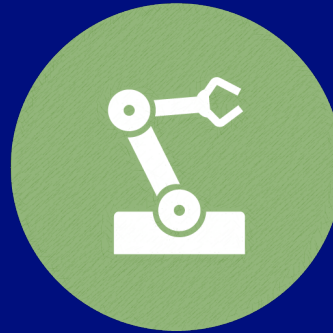


National labs are complementary to universities and industry in many ways



Universities

- PI- and peer-driven research on a project-by-project basis
- Diverse funding environment
- Abstract research



Industry

- Connection to market, national needs
- Pragmatic R&D



DOE labs

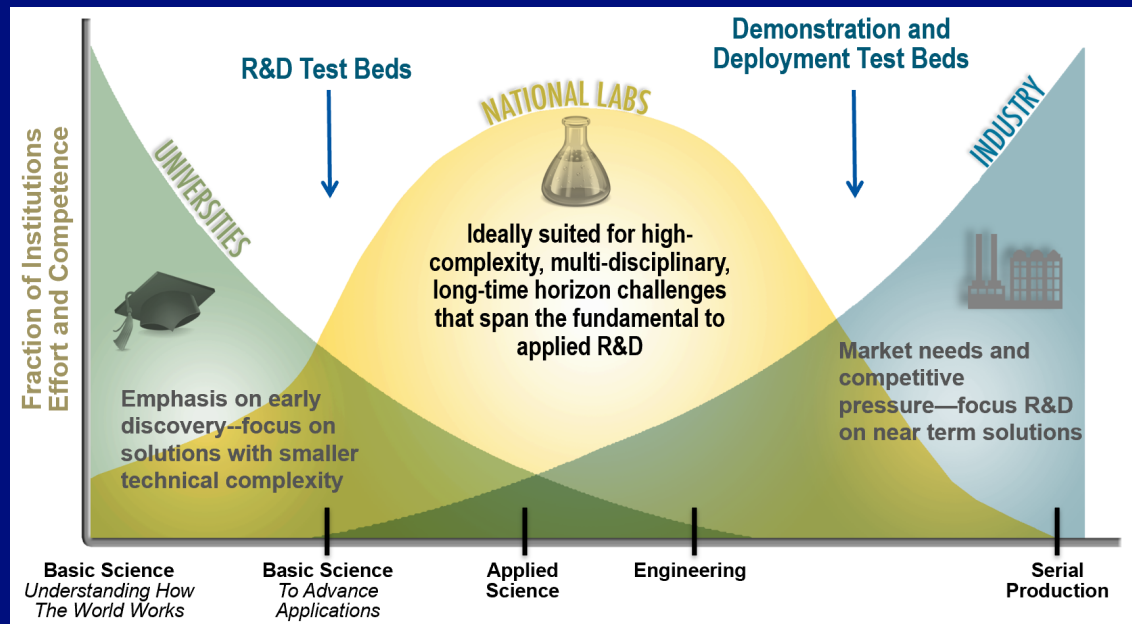
- Team science
- Facilities and projects of scale
- Interdisciplinary Integrator for long term, mission-driven research

Multi-decade R&D effort required

20- to 30-year horizon

- Define robust and sustained science and innovation agenda
- Focus on partnerships among
 - Universities
 - National laboratories
 - Government
 - Industry

Advancing tech: Role of DOE Labs in supporting entire technology lifecycle



Lab-industry partnerships support American science and the economy

Manufacturing

Energy

Information Technology

Pharmaceuticals



EMC²



P&G



SUNPOWER



Honeywell

HITACHI



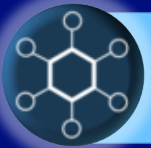
PIONEER.
A DUPONT BUSINESS

Lab networks: core, dynamic and rapid response



CORE

- Long term research in key areas of DOE mission
- Solving the immense problems that are facing the nation often requires specialized large-scale infrastructure and enduring expertise



DYNAMIC

- Addressing a problem of current national need on a 5-10 year timeframe



RAPID RESPONSE

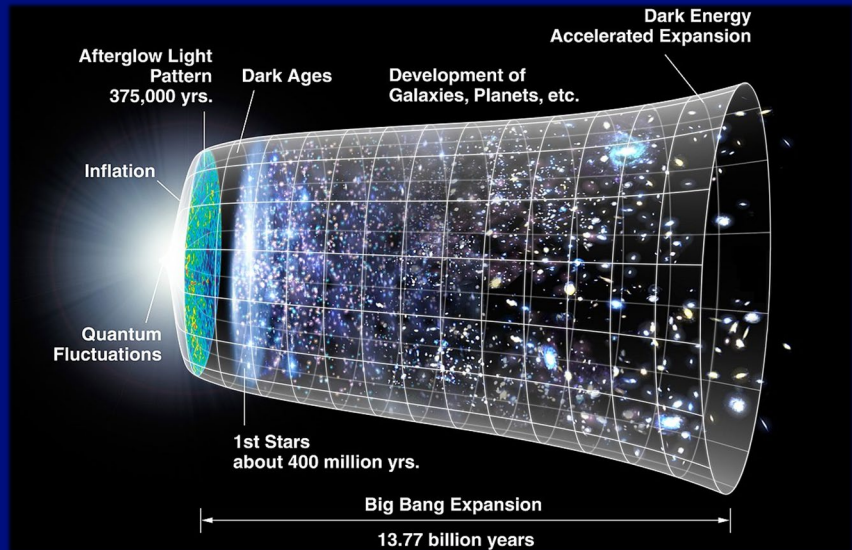
- Depth of expertise to adapt to urgent national needs
- Lab expertise can be quickly mobilized



Core network research and capabilities

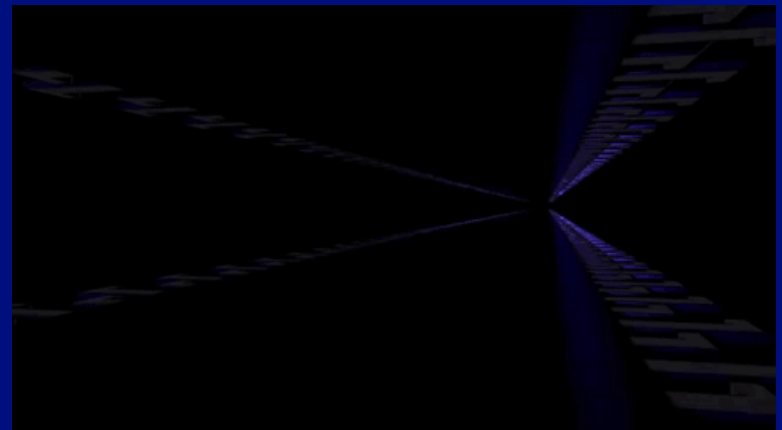
Physics and the universe

- Dark matter, dark energy, quark structure of nuclei, plasma physics and fusion energy, quark gluon plasma



Inventing accelerator science from Cyclotron to LINAC-based free electron lasers

- Superconducting RF for protons/electrons, high fidelity magnets, theory and modeling
- Neutron beams, heavy ion beams, x-ray lasers, beam dynamics, high power RF



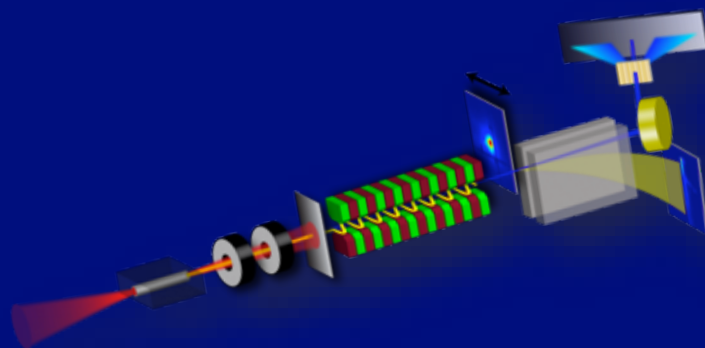
Core network research and capabilities cont'd

X-ray tools for science discovery, tech innovation

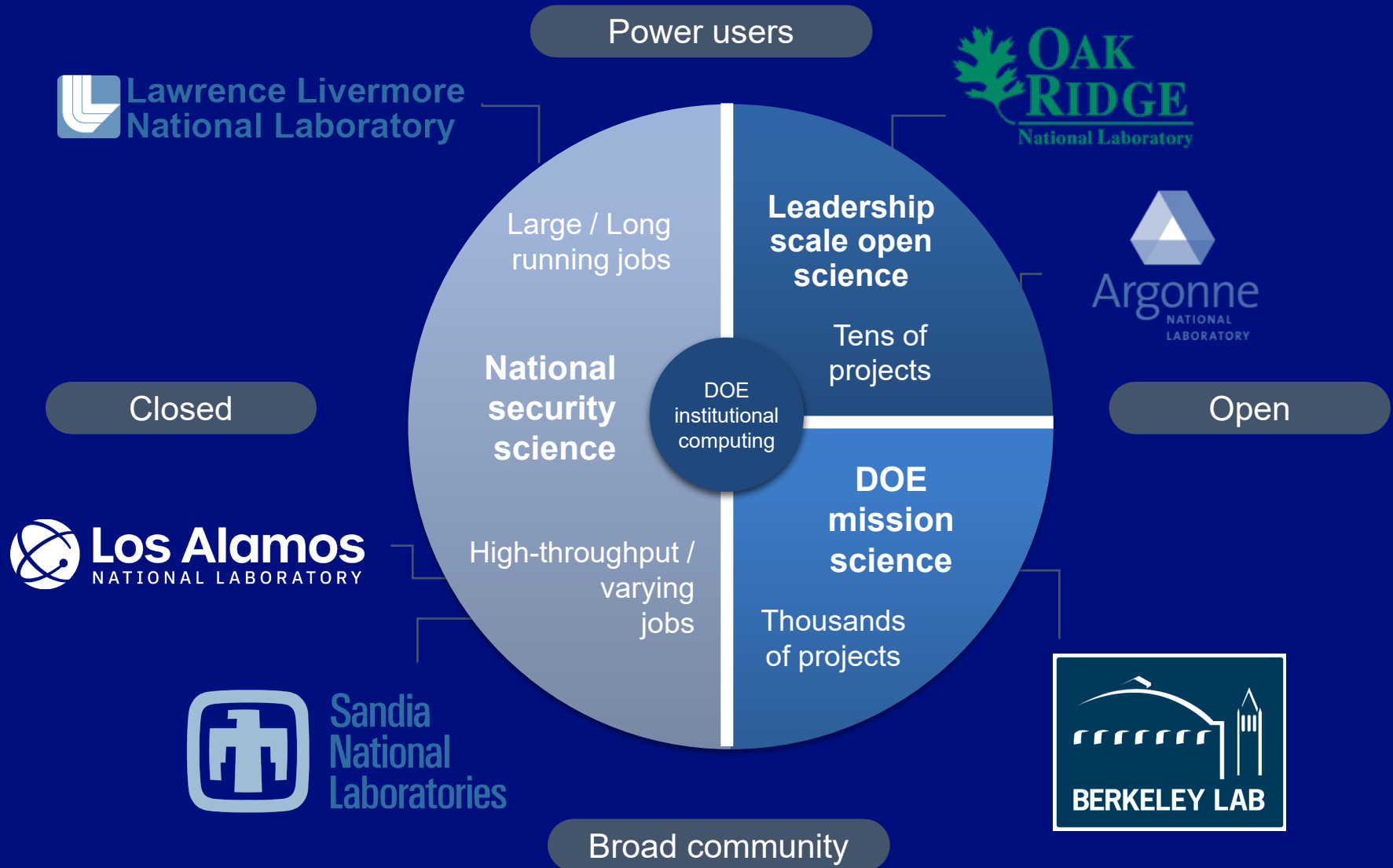
- **Advanced Light Source:** Provides soft(est) x-rays designed for surface chemistry and electronic structure
- **National Synchrotron Light Source II:** Provides hard x-rays to penetrate bulk materials with high brightness
- **LCLS & SSRL:** Provides hard x-rays and x-ray lasers for probing ultrafast dynamics in molecules and materials
- **Advanced Photon Source:** Provides hard(est) x-rays designed for bulk studies of real operating materials in real time in extreme conditions

Quick takes:

- Over 10,000 users from industry, universities and labs use the DOE Light Source Network each year
- Each lab has distinctive characteristics as well as overlapping capabilities which cover the discovery space and serves their geographic location and use base



Core network: High Performance Computing



Core network: safe, secure, effective nuclear deterrent

- Weapons operate in extreme pressures, temperatures, material velocities, time scales
 - Labs depend on *one-of-a-kind*, *classified* experimental, engineering, computational, and manufacturing tools and people to assess the deterrent without testing
- LANL: weapons design, materials, high explosive and actinide sciences; radiography, computing
 - LLNL: weapons design, laser/optics, HEDP, high explosives, computing
 - Sandia: design of nuclear weapon nonnuclear components, engineering, micro/nanoelectronics and sensors, manufacturing, systems engineering
- Labs have primary responsibilities for different warheads
 - Uniqueness of application mandates independent peer review between labs
 - Labs report to the President on the state and health of the nuclear deterrent



Dynamic network: Addressing COVID-19 and the next pandemic

➤ In March-April 2020

- DOE formed the National Virtual Biotechnology Laboratory (NVBL)
 - Single access portal for government, industry, and academia
 - Hosted end-user requirements workshops
 - Formed teams and coordinated R&D investments
- Labs supported NVBL and other internal and external initiatives

➤ In CY2020, by linking R&D and end-users, enabled

- Millions of masks and lab testing disposables
- Guidelines and efficacy evaluations impacting millions of diagnostic tests
- Onsite testing at multiple DOE locations
- Vaccine and therapeutic leads from modeling and experiments
- Web tools and reporting on virus evolution and potential impact on disease and erosion of diagnostics, and vaccines
- Epidemiological 6-week forecasts available on the web
- Epidemiological scenario models for national and regional decision makers



Rapid Response network



Pacific Northwest
NATIONAL LABORATORY



Los Alamos
NATIONAL LABORATORY



- Assessed “Breakout Timeline”: computer modeling (LLNL), enrichment expertise (ORNL), manufacturing (KCP), industrial/uranium processing (Y-12)
- Plutonium Pathway Eliminated: reactor conversion (ANL), heavy water expertise (SRNL).
- Provided quick response capability to assess negotiation proposals (24-7 hotline).

Rapid Response network cont'd

In the immediate aftermath of the 2011 Fukushima accident, national labs assessed consequences in Japan and potential impacts to U.S. regarding release of radioactive material from Fukushima Daiichi plant.



Rapid Response network cont'd

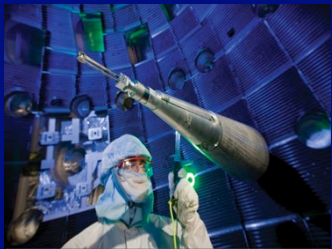
National labs continue to evaluate strategic and technological options; to engage in collaborative programs to expedite Fukushima clean-up and recovery; to enhance reactor safety world-wide.



Sandia
National
Laboratories



Global impact of lab networks



SECURITY

Stockpile
stewardship

Non-proliferation

Counterterrorism



RENEWABLE ENERGY

Wind

Solar

Electric cars



SCIENCE

115 Nobel Prizes

17 elements
discovered

Human genome
mapped

Dark matter

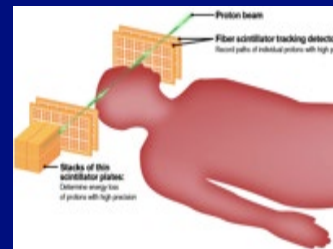
HPC



ENVIRO CLEANUP

Radioactive
waste disposal

Long-term
monitoring



HEALTH

Genetics,
genomics

Medical imaging

Cancer research

Pharmaceuticals

Summary

- DOE has extremely challenging and diverse missions, each born out of national need
- The national labs serve as the science and technology engine for DOE missions
- Each Lab stewards distinctive capabilities which DOE leverages through networks of labs address core missions, dynamic programs and rapid response needs
- National lab networks have transformative impact



Questions?